LSST:UK Newsletter 29 (December 2022/January 2023)

Introduction

There is quite a lot to report from the end of 2022 and the beginning of 2023, starting with a rather belated link to the 2022 Rubin Holiday card (see right).

The slides from the Rubin Town Hall held at the January AAS meeting are available on Zenodo. They contain too much information to be summarised adequately here, so I will restrict myself to a few points and suggest that everyone has a look over the slides. Perhaps most interesting are the details of the schedule change outlined in November. The updated schedule sees the formal start to Rubin operations in November/December 2024. However, there may still be some readiness activities to complete at that point, so the start of the survey is now expected between November 2024 and March 2025. Data Preview 1, which was to comprise commissioning data taken with ComCam, will now feature early data with LSSTCam, and is due in Fall 2024, with DP2 (containing data from the Science Validation surveys) to follow in (probably mid-)2025. Data Release 1, which will contain the first six months of survey data, is now expected to be published in late 2025 or early 2026. The *Rubin Observatory Plans for an Early Science Program* document has been updated to reflect these changes, and its current version will remain available from URL https://ls.st/esp.

The AAS Town Hall meeting also highlighted completion of the construction phase of the LSST Education and Public Outreach programme, and, in related news, the LSST:UK EPO Coordinator, Chris Lintott, outlined his plans for a UK EPO programme at the December meeting of the LSST:UK Consortium Board; Chris will report further on those plans in a future newsletter.

Meanwhile, construction work at the summit continues apace, with the Telescope Mount Assembly “99% complete” and good progress being made with the dome. Rubin have released a video of a recent drone flight around the nearly-complete dome.

Closer to home, STFC Science Board approved our Phase C funding (details below) at its December meeting, followed in early January by UK involvement in LSST being awarded *Very High Priority* status in the 2022 Roadmap produced by the Astronomy Advisory Panel. Taken together with the Business Case approval by BEIS reported in our November newsletter, this all reflects the solid, secure place that our project now has in the UK astronomy programme for the coming decade.

Finally, early January brought the very sad news of the death of Richard Bower. Comprehensive appreciations of Richard’s life and work will, no doubt, appear in various places soon, but I wanted to include a brief mention here of his role as a member of the Oversight Committee set up by STFC in early 2019 to monitor the funded LSST:UK Science Centre (LUSC) programme. Richard was exactly the “critical friend” that one wants OsC members to be. Ill health caused him to miss some the committee’s meetings, but when he was present he was always fully-engaged, insightful and positive - as, indeed, he was in pretty much everything that I saw him do in the 20+ years that I knew him. It was often one of Richard’s questions that I found my mind returning to after an OsC meeting, reflecting that, while presented with a broad smile, there was a significant point behind it that needed further thought. I am very sorry that we will not benefit further from that friendly, yet challenging, scrutiny, and I will miss the enthusiasm with which he always spoke of the scientific opportunities that LSST will provide for our community. I’m sure that all members of that LSST: UK community will wish to express sincere condolences to Richard’s family and to the friends and colleagues who were closest to him.

Those with ideas for future newsletter items should contact the LSST:UK Project Managers (@ George Beckett and @ Terry Sloan lusc_pm @mlist.is.ed.ac.uk), while everyone is encouraged to subscribe to the Rubin Observatory Digest for more general news from the US observatory team.

@ Bob Mann

Phase C funding outcome

The December STFC Science Board meeting endorsed PPRP's recommendation that the LSST:UK Science Centre (LUSC) Phase C proposal be funded in full, except for a 50% reduction to the travel funding associated with the Work Packages, which reflects the fact that fewer in-person meetings are likely in Phase C than in Phase B; N.B. the Pool Travel Fund is unaffected. That was an excellent outcome, reflecting the tremendous work performed by all those who contributed to the Phase C proposal and those - mainly the same people - whose successes in Phases A and B convinced PPRP that our Consortium is worthy of increased investment for Phase C.

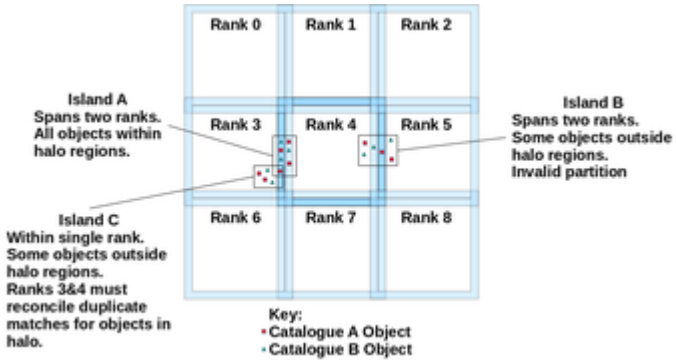
Essentially, the Phase C funding will cover the UK's in-kind contributions to Rubin operations for the period April 2023 - March 2027, plus the management effort needed to support them. There are four top-level Work Packages:

- **WP1: LUSC-MAN**. This supports the LUSC project office - i.e. Project Leader, Project Scientist, Project Managers, Project Assistant, Data Facility Advisor - plus UK contributions to Rubin Commissioning, Aprajita Verma's role as leader of the Rubin In-Kind Program Coordination team, contributions to the IRIS sites that host LUSC hardware and the Pool Travel Fund. New for Phase C are (a) a Communications Officer role, intended to aid communications within the Consortium and to help Consortium members communicate with the media; and (b) a Community Scientists scheme that will support part-time secondments to the Rubin Community Engagement Team.
- **WP2: LUSC-DAC.** This will continue the work undertaken in Phases A and B preparing for a UK LSST Data Access Centre, which will enter operations during Phase C.
- **WP3: LUSC-DEV**. By far the largest WP, this comprises nine software development projects, providing code and data to a range of recipient groups, from Rubin Observatory teams to Science Collaborations, plus operation of Lasair, the UK's Community Broker. Most of the DEV projects are continuing from Phase B, but Phase C will see the start of work on Adler, which will provide functionality for solar system transient classification building on Lasair, and a contribution to the Dark Energy Science Collaboration's preparatory work on galaxy clustering.
- **WP4: LUSC-DRP**. This WP covers the staff effort required for the UK's quarter share of the LSST Data Release Production workload.

Further details of all four WPs can be found in the LUSC Phase C proposal, and will be presented in future Newsletters, as well as in updated versions of the LSST:UK website and wiki to be launched in time for the start of Phase C.

@ Bob Mann

Speeding up the search for photometric catalogue counterparts in the LSST:UK cross-match service



The biggest challenge astronomy is facing with the Vera C. Rubin Observatory's LSST is that of "big data." The number of objects the telescope will observe is at least ten times larger than the biggest current photometric catalogues, bringing a host of computational complications that must be overcome to provide robust data for scientific use.

One of the projects LSST:UK is working on at the moment is a catalogue cross-match service. As discussed previously in Newsletter 10, one of the issues with LSST is that the density of objects (number of objects per Point Spread Function area) is so high that standard matching algorithms will fail, necessitating the development of more complex algorithms. The main developments our cross-match service will uniquely provide are in its fully-symmetric matching in a so-called "many-to-many" fashion, where competing sources in both catalogues being matched are allowed to be potential counterparts to any source in the opposing dataset, but also in the way it is able to take into account the higher-order effects of such density of detections on the sky, and the effects this has on the measured positions and magnitudes of detected sources.

The downside of this complexity is, well, its complexity. We are no longer able to rely, as so many have before us, on the assumption that the uncertainty in an object's measured position is of Gaussian shape (this being just one of several contributions to object position precision), and must turn to numerical, rather than analytic, methods for several key areas of probabilistic cross-matching. No longer being able to directly solve the mathematical equations and instead being forced to run simulations to calculate the needed answers results in a longer runtime -- up to months in some cases! -- which, when combined with LSST's increased source count, quickly becomes impractical for getting LSST-to-other-catalogue counterparts figured out and available for scientific use in a nice, short turnaround time.

However, in the fight against big data we can turn to big computation! Here we can leverage big data facilities, such as the Cambridge Service for Data-Driven Discovery, to distribute our problem of counterpart assignment and catalogue cross-matching across many computational nodes, breaking the task up into smaller, more tractable bits of the sky. One of the advantages of working within a large collaboration is the ability to call on experts in a wide range of topics. Enter Dominic Sloan-Murphy from the EPCC, who was able to maximise the efficiency of these large compute clusters and get the software running on the full array of compute resources available. Distributed memory parallelism has been enabled through MPI, the Message Passing Interface standard for parallel computing, adding to the pre-existing OpenMP-based shared memory parallelism to create a hybrid application ensuring efficient use of memory and compute resources, both within a single supercomputer node and across the full system. With the implementation of wide-scale parallelisation -- and the ability to break the sky into

small regions to be cross-matched separately -- we will be able to turn around LSST cross-matches on a much quicker timescale (days to a week), providing information on the counterparts between LSST and other key photometric catalogues for astronomers to use for their own science.

This marks the final stages of development of "v1.0" of macauff, the LSST:UK photometric catalogue cross-match service software. We are now working with the UK Data Access Centre team to perform crucial all-sky matches of key catalogues to stress test both the software and our wider pipelines for ingestion of the value-added datasets into the UK's Rubin Science Platform. As a byproduct of this testing we will be releasing cross-matches of various "legacy" catalogues, available for users through the UK RSP.

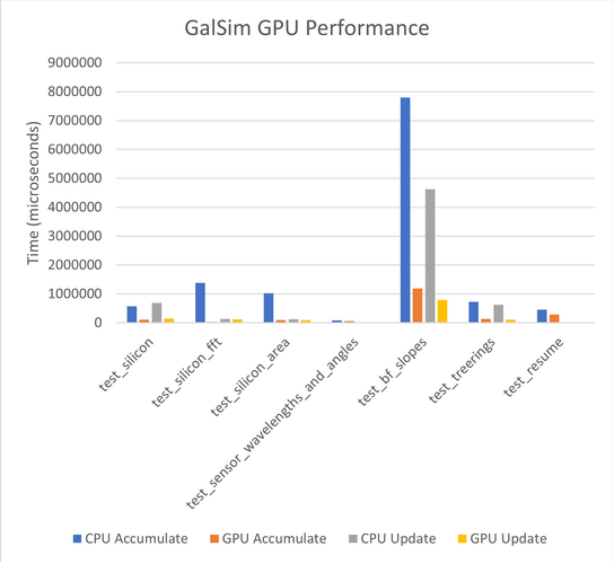
@ Tom J Wilson , @ Tim Naylor and @ Dominic Sloan-Murphy

GalSim GPU Porting

As part of Phase B WP3.10's contribution to DESC, I have been working on porting the GalSim sensor model to GPU over the past several months. GalSim is the low level library that forms the core of the ImSim image simulation code used extensively in DESC, and we have previously contributed various improvements to this library, including parallelising the main photon accumulation loop using OpenMP, and modifying how the sensor pixel geometry is stored.

I have added GPU acceleration to the photon accumulation and pixel boundary update loops using OpenMP Target Offload. This same technology is being used elsewhere in DESC's image simulation pipeline, and it meets DESC's requirement for a portable, platform-neutral GPU solution. It uses a directives-based approach requiring relatively little modification to the original C++ code. However, OpenMP Target Offload is still quite immature, and I encountered several problems (mostly compiler related) that had to be worked around. The porting work was done on NERSC's Perlmutter GPU system, though I am also now testing on Cirrus at EPCC, using the Clang compiler.

The porting is now complete and after debugging I am able to run the entire GalSim sensor test suite on GPU. The performance is better than expected, with the main accumulation loop running on average 3.9x faster on GPU than on CPU across all tests. However, when the photon arrays are already stored in GPU memory, this increases to 18x faster. The eventual aim is to integrate this work with other parts of the simulation workflow so that the photon data can be generated on the GPU and fed straight into the sensor model without ever having to leave GPU memory, and it appears that this may unlock a potentially large speed up.



@ James Perry

Recent LSST:UK Science Centre outputs

The LSST:UK Science Centre has recently produced the following technical reports.

Title	Author	Description

D3.6.1 Report/documentation on impact of observational effects and their spatial variability on photo-z, based on simulations	Qianjun Hang, Benjamin Joachimi (University College London)	The WP3.6 team investigated how different observational effects such as sky brightness, seeing, and number of exposures can affect the photometric redshift (photo-z) distribution for LSST. The observation strategy for Rubin is to cover a large survey region before building up the depth. During the first few years of observation, therefore, it is expected that the inhomogeneity in depth due to e.g. varying weather condition is large. Effectively, one can regard each pointing as a 'mini' survey with different observational systematics and limiting magnitudes. This could potentially be a problem for weak lensing analysis because the signal is sensitive to the mean redshift of the tomographic bin, especially for the precision required by LSST. In this investigation, the WP3.6 team focus on the 'gold' sample from the first (Y1) and fifth year (Y5) data release, for which the simulated observation conditions for the Rubin Observatory (OpSim) as well as the DC2 DM catalogue are used. We split the sample into tomographic binning for lens sample between 0.1 in 0.2 z 1.2 according to Y1 and Y5 requirements respectively. One of the main aims is to check whether the spatially varying observing conditions introduce fluctuations to the mean and scatter of each tomographic bins that are larger than the Rubin requirement. The photo-z is estimated using a template-fitting algorithm, BPZ lite. We find that for the sample with reduced photo-z outliers, the shifts in the mean redshift and the scatter in each tomographic bin is consistent with the random noise of the sample, and comparable to the Rubin requirement. Additionally, we also looked at the impact of spatially varying observational conditions in each band on the cModel magnitude, the magnitude error, colour, and galaxy over-density

@ Terry Sloan

Forthcoming meetings of interest

There are a number of meeting updates to report on this month. Please check-out the links below for more details.

The first announcement of the **LSST@Europe 5** meeting has been made. The meeting will be held in Pore, Croatia, during 25th--29th September 2023. Registration information is expected to be published by end of March 2023.

The dates have also been confirmed for the **Rubin Project and Community Workshop 2023**: it will be held on 7th--11th August in Tucson, Arizona. More details are expected in the coming weeks.

The IDAC coordinators (along with representatives from LSST:UK, LIneA, and the LINCC programme) are organising an IDAC workshop during 21st--22nd March 2023, entitled **Supporting Computational Science with Rubin LSST**. The workshop will be virtual and pre-signup is now available.

Other meetings of potential interest for the coming months include:

- 27th February – 3rd March: DESC Collaboration Meeting (virtual). Details to be published on DESC members website (login required).
- 24th - 28th July: DESC Collaboration Meeting (SLAC).

Members of the Consortium (not in receipt of travel funding through one of the Science Centre grants) may apply for travel support for meetings of this kind via the the LSST:UK Pool Travel Fund. Details are available at Forthcoming LSST-related Meetings .

Note that the current list of forthcoming meeting is always available on the Relevant Meetings page. You may also wish to check information held on the LSST organisation website LSST-organised events and the LSST Corporation website.

@ George Beckett

Announcements

If you have significant announcements that are directly relevant to LSST:UK and would like to share the announcement in a future newsletter, please contact the LSST:UK project managers.

@ Manda Banerji writes:

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> *I have an opening in my group in Southampton for a research software scientist to work on one of the UK's accepted in-kind software and dataset contributions to the Rubin LSST project. The project is delivering a pipeline for joint pixel processing of LSST and VISTA VIRCam imaging data and is in its second phase of funding. More details can be found here:*
>
> *https://jobs.soton.ac.uk/Vacancy.aspx?ref=2152223WF*
>
> *I would be grateful if you could please advertise this opportunity to any suitable candidates. We are particularly keen to attract those from under-represented groups in Physics who are typically severely under-represented in software/technical roles. Please do encourage anyone interested to get in touch with me directly to find out more about the role.*

The application deadline for this post is **Sunday, February 26th**.